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The Impacts of Climate Change on Livelihoods in Northern Ghana: Could Shea (*Vitellaria paradoxa*) Ecosystem Services Be a Panacea?

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Abstract

The reality of climate change in the northern regions of Ghana is noticeable among the inhabitants of the territory. One of the obvious impacts of climate change is the reduction in numbers and yield of the indigenous cash tree, shea tree in the region. This study explored the influence of ecosystem services of shea tree in promoting the adaptation strategies among community members of the Lawra Municipality of the Upper West Region. This study involved a stratified sample of 387 community members and four key informants. Using mixed-research methods and guided by environmentally-specific transformational leadership theory, this study revealed that the shea tree provides ecosystem services such as provisional ecosystem services, regulating ecosystem services, supporting ecosystem services and cultural ecosystem services. The specific services include food, income, cosmetic, buffer, habitat, shelter, microclimates, absorb flood, folktales, aesthetic, and traditional knowledge. The one-way Anova results showed that the provisional and regulating ecosystem services significantly differed across zones, age and educational levels of participants. Second, the study showed that ecosystem services significantly contribute to climate change adaptation among the inhabitants of Lawra municipality. The Ordinary Least Square results (B = 0.001, t = 0.03, $p = 0.977$*) showed that supporting ecosystem services have a significant and positive impact on climate change adaptation. This study recommends that policy makers should take active role in providing effective climate change and adaptation communication plan to enhance climate change response among communities in Ghana.

Keywords

Climate Change, Climate Change Communication, Shea Tree; Ecosystem Services, Climate Change Adaptation

1. Introduction

Climate change is a significant worldwide concern that endangers both human and environmental systems (Robertson & Barling, 2013; Gyasi et al., 2023). Climate change is the shift in either the average climate or climate variability that persists over extended period (Riley, 2016). Natural fluctuation and human activity are typically identified as the two main causes of climate change, with anthropogenic factors (human activity) accounting for the majority of the phenomenon (Intergovernmental Panel on Climate Change, IPCC, 2007). In the IPCC report, Stocker et al. (2013) observed that the rise in atmospheric carbon dioxide is the main source of the warming, and it is "extremely likely" that human activity has been the primary driver of this warming since the middle of the 20th century. Climate scientists have identified two types of responses to the threat: adaptation and mitigation. Mitigation involves a lowering of greenhouse gas emissions from human activity to lessen the severity of climate change (Stocker et al., 2013). On the other hand, adaptation is the process by which people adjust to climate change by taking steps to mitigate or prevent adverse effects while taking advantage of positive ones (Stocker et al., 2013). This could entail constructing coastal defenses to stave off sea level rise or switching to crops that do well in the altered climate. Climate change adaptation is therefore, one of the effective means to mitigate the threats of climate change (Gyasi et al., 2023; Stocker et al., 2013).

While general climate change adaptation is useful (Gyasi et al., 2023), the need to identify specific climate change adaptation strategies in relations to specific threatened species of ecosystem is far rewarding. This calls for understanding the relationship between ecosystem services of the specie influence on climate change adaptation of people. This call is worth answering due to the exacerbating impact of climate change on less economically endowed regions (Leichenko & Silva, 2014). For instance, in Ghana, the incidence of poverty is higher in the northern part of the country than in other areas. The Lawra Municipality has one of the highest incidents of poverty in the country with an estimated poor population ranging between 30,000 and 49,000 (Ghana Statistical Service, 2014). Considering the fact that Ghana's 2021 Population and Housing Census put the total number of people in the area to be 58,433, it means almost everybody in the study area is considered poor.

There is therefore, the need to harness every resource in the area in order to build the resilience of residents against climate change impacts. The shea tree which is one of the most economically viable trees in the area, is a non-timber forest product. Caspa et al. (2020) opined that non-timber forest products provide

humankind with fruits, roots, seeds, nuts, barks, fungi, resins, feathers, bush meat, fibers and leaves. These serve as sources of food, income, medicine, construction material and fuelwood, as well as resources of spiritual and cultural significance (Caspa et al., 2020). An investigation about the nutritional values of the shea fruits by Adazabra, Dotse and Alhassan (2013) reveal that the tree is an important ecological, nutritional and socio-economic resource for upgrading the standard of living of the indigenous population in the Sudano—Sahelian region of Ghana. With the shea tree importance to local livelihoods and ecological sustenance clearly established, knowledge about its conservation will help many communities maintain and improve their sources of livelihoods and this will surely complement climate change mitigation and adaptation efforts in those communities.

Talking about climate adaptation and mitigation, conserving the shea tree will directly contribute to the realization of Sustainable Development Goal (SDG) 13 which is about taking action to enhance climate change mitigation and adaptation. The survival and conservation of the tree may help realize SDG 1, which is about ending poverty in 2030 since many people depend on the shea value chain for their source of livelihood. In the advent of climate change and its adaptation efforts, individuals and communities need resources to adapt to the impact of the phenomenon and the shea tree, which is an invaluable environmental resource to residents in its biome, and serves as a very important source of livelihood. Unfortunately, the tree is under threat from both natural and anthropogenic factors, and there is no available knowledge on how to conserve it (Quainoo, 2019).

The inadequate knowledge on its conservation can lead to over exploitation of the product resulting in deforestation, which causes loss of biomass and biodiversity, increase in particulate matter and carbon concentration, disruption of the water cycle and increase in soil erosion. Moreover, inadequate knowledge of its conservation can also lead to the depletion of the shea tree in its biome thereby depriving the demonym of a very vital traditional and economic product which can serve as an invaluable resource in their climate change adaptation efforts. While the economic importance or value of the shea tree is not in doubt, there is no known available study especially in Ghana that has established the contributions of shea trees to climate change adaptation in the country. One of the known studies by Gyasi et al. (2023) examined the organizational level climate change adaptation policies and behaviors. The authors found that Newmont Mining Company adopted several pro-environmental behaviors, such as reduction in emission, recycling, re-use among others that enhanced environmental sustainability. Instead of organizational level like Gyasi et al. (2023), this present study assesses the contributions of the shea tree to climate change adaptation. This study focuses on answering these two research questions:

1) How essential is the shea tree in providing ecosystem services to indigenes of Lawra municipality?

2) How do these ecosystem services, if any, help in climate change adaptation in the study area?

2. Literature Review

Scientific Basis of Climate Change Globally

The scientific basis for climatic change phenomenon reports the emission of greenhouse gases as a major cause of climate change. In a comprehensive report on development of plan for climate change, Bertoldi et al. (2018) discovered the covenant may take into account the three primary long-lived greenhouse gases, CO_2, CH_4, and N_2O. The major concern is the anthropogenic factors that contribute to increase emission of these gases (Stocker et al., 2013). For instance, in the present study area, Lawra municipality, there is increasing activities of deforestation, fuel wood, bush fires, hunting among others that affect climate especially the shea tree (Diko et al., 2021). It is not surprising therefore, that studies are establishing climate change manifestations in the area. For instance, in a community-by-community report, Abdulai et al. (2017) explored climate change occurrence in Lawra municipality and found that climate change has altered rainfall patterns, seasonal shifts, and early drying of open water sources, all of which indicate that the climate in the area is changing (Abdulai et al., 2017).

This confirms the observation by climate scientists that rural livelihoods are at risk from a number of factors, including decreasing rainfall amounts, rising sea levels, melting glaciers, unpredictable occurrence and duration of agro-seasons and rains (IPCC, 2007; 2012), variations in rainfall patterns, and rising temperatures (Gyampoh et al., 2008) because of climate change. This is especially true in light of the fact that climate change modifies the physical geography of regions, causing the extinction of wildlife, plants, and other natural habitats that are essential to rural livelihoods. The fact that the impoverished in rural areas have little ability to adjust to the changes exacerbates the situation (Diko et al., 2021).

It is noted that perceptions and knowledge of people about climate change is crucial for understanding the adaptation and communication systems adopted for dealing with climate change. Abdulai et al. (2017) explored the impact climate change in Lawra District and the coping strategies deployed by the people to deal with the phenomenon. The authors gathered from ten communities in the district through focus group discussion with opinion leaders in the communities. Using content analysis, Abdulai et al. (2017) discovered the phenomenon of climate change is known among the rural people in that they attribute the incidence of erratic rainfalls, incessant drought, pest outbreaks, floods and low yield of crops as caused by climate change. that Abdulai et al. (2017) discovered that Lawra district people cope with climate change through mobility to southern part of Ghana, communal pooling and agriculture-related changes, use of resistant varieties of crops and food storage against famine. Abdulai et al. (2017) called on government agencies to consider increasing awareness creation as well as the Ministry Education incorporating climate change into the educational system. The study of Abdulai et al. (2017) discloses that the people of Lawra have some level of knowledge on climate change. The knowledge, though unscientifically verified, the people are convinced by observation of the rainfall patterns, floods, drought, pests among others as signs of climate

change. The understanding of the anthropological and ecological factors that contribute to the cause of climate change are known. For instance, the people of Lawra could not explain how greenhouse gases, deforestation among others could contribute to climate change in their district (Abdulai et al., 2017). Therefore, the knowledge and perceptions of people about climate change is basically based on the outcome of climate rather than the causes and solutions to climate change.

Likewise, Diko et al. (2021) explored the incorporation of Climate-Smart Agriculture (CSA) in the Upper West Region of Ghana. The authors assessed the incorporation of CSA into the district development plans. From the assessment, Diko et al. (2021) discovered that the use of the concept "climate change" in the eleven MTDPs was 34.3 times; while CSA appeared 5.5 times. In a district specific analysis, Diko et al. (2021) discovered that Lawra Municipality's MTDP recorded the lowest count (7) for climate change, while the Nadowl-Kaleo District recorded the highest count (73). Moreover, Diko et al. (2021) found that the narratives depict awareness of climate change and its impacts in that with the exceptions of Wa East District and Wa West District MTDPs, the other nine explicitly identify the impacts of climate change on agriculture. Nonetheless, Diko et al. (2021) found out that there was absence of climate data in the majority of the MTDPs. The reliable data is critical for understanding the location, extent, and severity of climate change impacts to inform appropriate strategies in building adaptive and resilience capacities of the agriculture sector both in the present and for the future. Gyasi et al. (2023) explored the organizational level approach to addressing climate change which is largely policy oriented than practically implemented by the companies. In essence, the present scope of literature on climate change and its adaptation seems to suggest awareness and knowledge of coping strategies, but there is little or no knowledge on the relationship between ecosystem services and climate change adaptation among indigenes. Moreover, while Gyasi et al. (2023) discovered the instrumental role of company leaders in promoting pro-environmental behaviors; there is literally lack of knowledge on instrumental role of transformative community leaders' influence on climate change adaptation.

3. Theoretical Framework

Background of Environmentally-Specific Transformational Leadership Theory

This theory underscores the centrality of leadership attitude and roles in realizing the goals of every environmental communication, education or campaign. The theory regards quality and effective leadership as a *sine qua non* in every endeavor that seeks to communicate and raise awareness about environmental management and sustainability. Proposed by Robertson and Barling (2013), the theorists argued that leadership style could enhance pro-environmental behaviors in among people. Transformational leadership includes four behaviors namely: idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration (Bass, 1998; Bass & Riggio, 2006). The application of these behavioral leaders' behaviors can influence environmental sustainability within an or-

ganization, and by extension community. First, idealized influence centers on leaders becoming role models by doing what is right rather than what is expedient. Second, leaders high in inspirational motivation stimulate their employees or subordinates to go beyond their individual needs for the collective good; they inspire subordinates through their own passion and optimism to overcome psychological setbacks and external obstacles, and to go beyond what is good for themselves by engaging in behaviors that benefit the natural environment (Robertson & Barling, 2013). Third, intellectually stimulating leaders encourage employees to think for themselves, question long-held assumptions, and approach problems in innovative ways (Robertson & Barling, 2013). Finally, leaders who exhibit individualized consideration display compassion and empathy for employees' well-being and help employees develop their potentials and skills.

In the present study, the researchers will observe how empathy and compassion for community members among stakeholders could inform friendly climate change practices among community members. This could be in the form of interventions by leaders to address certain climate change or environment concerns within a given community. The present study finds this theory as vital in understanding how the various institutional leaders could employ either or all the transformational leader behaviors to change attitudes, believes and practices of community members about climate change and its communication. This theory aids in understanding the pro-environmental activities of communities under study and the extent to which such behaviors could affect the overall performance of the community on climate change issues (**Figure 1**).

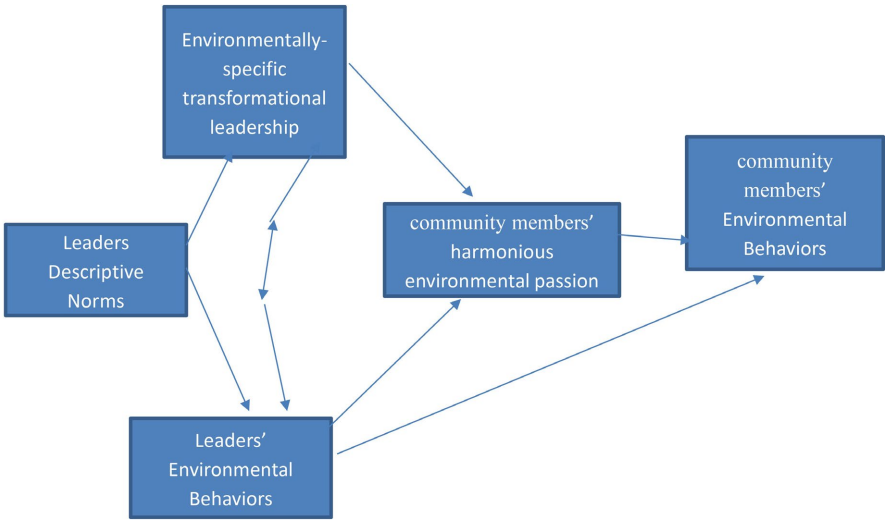

Figure 1. Environmentally-specific transformational leadership model.

4. Methodology

4.1. Research Site

The site for this research is the Lawra Municipality in the Upper West Region of Ghana. It is one of the 261 District, Municipal and Metropolitan Assemblies

(MMDAs) in Ghana and forms part of the 11 District and Municipal Assemblies of the Upper West Region. It is bordered to the west by the Black Volta River which serves as the border between Ghana and Burkina Faso and to the south by Nadowli and Jirapa Districts, both in the Upper West Region. The Municipality shares borders to the east with Lambussie/Kani District and to the North with Nandom District.

Information about the Municipality from the 2021 Ghana's Population and Housing indicates that the Municipality has a total population of 58,433 comprising a rural population of 48,962 and urban population of 9471. About 82.4 percent of the inhabitants engage in agricultural, forestry and fishery works while 7.8 percent engage in craft and related trade. Others, 3.6 percent engage in service and sales. About 3.1 percent are engaged as managers, professionals, and technicians.

Clearly, an overwhelming majority of the people in Lawra Municipality live in rural areas, and agriculture is their main occupational engagement thereby making the Municipality hugely vulnerable to the effects of climate change since the kind of agricultural activity carried out is rain-fed crops cultivation. The choice of this study area was largely based on its agro-based economy and the presence of shea tree in this municipality.

4.2. Research Approach and Design

The research used the mixed method design, specifically the exploratory sequential research design to conduct the research. The choice of mixed-method approach allowed the researchers to combine both quantitative and qualitative data to address the research questions that underpinned the study. The sample size for the survey was determined using the household population as the unit of measurement. Per the 2021 Population and Housing Census (PHC) results, the Lawra Municipality had a total population size of 58,433 of which the rural population was 48,962. The total number of households was 11,967 while total household population in the area was 56,396.

The target population for this study was the indigenous population of Lawra Municipality, officials of media houses in Ghana, traditional authorities, silvicultural research institutions, civil society organizations and local government institutions. The Raosoft formula was used to determine the sample size:

$$x = Z\left(c/100\right)^2 r\left(100-r\right)$$

$$n = Nx/\left(\left(N-1\right)E^2 + x\right)$$

$$E = Sqrt\left[\left(N-n\right)x/n_{(N-1)}\right]$$

N is the population size, $Z(c/100)$ stands for critical value for c which is the confidence level. The r is the fraction of responses the study is interested in while n is the sample size. The E is the margin of error determined for the study. Upon using this formula, the sample size for this study was 373. Knowing the importance gender variable in the present study, the researchers ensured stratified sampling across zones and gender variable to ensure inclusive and representative

data. Survey instrument focused on eliciting demographic information, specific ecosystem services derived from shea tree based on the four ecosystem services categories: provisioning, supporting, regulating and cultural ecosystem services. The focus group discussion used semi-structured interview guide based on research questions that underpinned the study.

The qualitative data was analyzed manually and technologically. The manual analysis involved playing the tapes of the focus group discussions and coding the transcribed data; while the technological analysis employed the use of Nvivo software to generate codes. For the questionnaire, the items were analyzed using the statistical software such-Statistical Package for the Social Sciences (SPSS) version 28.0.

Wimmer and Dominick (2011, p. 65) stated, "the best reason to behave ethically is the personal knowledge that you have acted in a morally appropriate manner. Wimmer and Dominick (2011) identified three main ethical considerations for a study involving content analysis. One is the need to avoid fabrication. This involves being real and accurately reflecting the views of the participants in the study. In this study, the researcher ensured that sources other than the author's own ideas are appropriately referenced. Finally, the researcher ensured informed consent. The participants were duly notified through written letters to participate in the study. In cases where participants are not educated formally, the researcher resorted to word-of-mouth informed consent in order to explain the purpose of the study, and ask for their willful participation. Bearing in mind the fact that participants are in the working class, the researcher allowed participants to decide the time and venue that is conducive and convenient for them to participate in the study.

4.3. Findings and Discussion

This section focuses on answering the research questions that guided the study, thus how essential is the shea tree in providing ecosystem services to indigenes of Lawra municipality, and how do these ecosystem services, if any, help in climate change adaptation in the study area?

4.4. Demographic Information of Respondents

The demographic data of respondents presented in this research are those variables of the respondents that are considered important and impactful on the study. It contains data on variables such as age, zone, gender, educational level and occupation.

1) Ages of Respondents

In many societies, age is a very important demographic determinant in the participation of some activities and endeavours. It is particularly important in climate change studies if responses sought are of chronological or historical importance. In this study, the ages of the respondents who took part in the survey are presented below.

From Table 1, apart from a single respondent who was below 30 years, all the

other respondents were at least 30 years or above that. This information is important in underscoring the fact that the respondents were old enough to provide responses about their experiences and observations on climatic and environmental phenomena over the past 30 years. The significance of the minimum age of vast the majority of respondents being 30 years lies in the strength of the definition of climate as provided by IPCC (2012). It defines and explains climate as "the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to 15 thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. Besides the ages of the respondents being linked to the validity of responses they provided, age is also considered a determinant in driving climate change activism in communities. According to the United Nations Framework Convention on Climate Change (UNFCCC) (2021), "older people in fact hold diverse experiences and knowledge around how climate can impact their communities, are socially connected and hold moral authority within their communities". They add that "older people and their civil society presence are well placed to mobilise other members of their communities and use their collective political capital to call for political leaders to respond to the climate crisis".

Table 1. Age distribution of participants of the study.

Ages	Frequency	Percentage
Below 30	1	0.3
30 - 40	32	8.2
41 - 50	127	33
51 - 60	105	27
Above 60	122	31.5
Total	**387**	**100**

Source: Field Data.

2) Other Demographic Information of Respondents

The study also captures other demographic information of the participants or respondents which are considered relevant in meeting some of the research objectives. Four of such information is presented below. These are zones, gender, education and occupation.

From the bars representing the zones of the respondents, it is indicated that 108 respondents were selected from the Domwine-Eremon zone, 130 from the Lawra zone and 148 from the Babile zone. Presenting data on the number of respondents in the survey from each zone is important in ensuring representativeness and inclusivity of the data and respondents respectively. Gender-related factors and processes can influence inequalities to access and use of environmental resources (Gumucio et al., 2020). The shea tree is an environmental resource and there could be gender dynamics on how its resources are accessed and utilized. Thus, it is im-

portant to have the different genders represented in the sample to ensure balance and representation of their views. The second chart in Chart 1 represents the gender of respondents. Out of the total 387 respondents, 265 representing 68.5% indicated that they are male while 121 representing 31.5% indicated that they are female. Relating this important observation to the respondents, those without formal education 243 representing 63% of the sample size while those who are educated up to the certificate level are 87 representing 22% of the sampled population. Those with tertiary education were 40 constituting 10% of the respondents. Going by the position of UNFCCC (2021), it means climate change and environmental communicators or educators in the Lawra Municipality have to make more efforts in making people appreciate the issues being communicated since most of the people have no formal education or are minimally educated. As many as 323 respondents constituting 84.1% of the sample are farmers and 17 respondents representing 4.4% are into trading. Those into artisanal works are 20 and this represents 5.2% of the population. This occupational finding is very important as it speaks volumes about the vulnerability level of residents in the Lawra Municipality to climate change.

4.5. Ecosystem Services Provided by the Shea Tree

The **first research objective** focused on examining the ecosystem services provided by the shea tree and the state of its conservation in the Lawra municipality. Ecosystem services are the benefits that people derive from an ecosystem (Proctor, 2014). Expanding the definition further, he says "ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life".

From the data gathered in the present study, the researcher discovered four major types or categories of ecosystem services, which are provisioning ecosystem, services, regulating ecosystem services, supporting ecosystem services, and cultural ecosystem services. Each of these four categories contains specific benefits, thus ecosystem services elicited by the researcher from the participants through the qualitative and quantitative data gathered.

Provisioning Ecosystem Services

Provisioning services are explained as products obtained from ecosystems. They include food, fresh water, fuel, fiber, biochemicals and genetic resources.

The autochthones and residents of Lawra Municipality of Ghana derive a lot of provisioning ecosystem services from the shea trees within the area. In the opinion of officials of the Lawra Municipal Assembly, the shea tree "*is a main source of livelihood and the lives of many people depend on it*". This assertion underscores the centrality of shea tree, and its products in sustaining life and wellbeing of people within the Lawra Municipality. The Forestry Commission officers within the Municipality described the shea tree as the "cocoa" of Northern Ghana. In a detail manner, the paramount chief of Lawra traditional area described the provisioning ecosystem services as follows:

"*The shea tree plays a very vital role in our economic system especially within*

the Lawra Municipality. Most people in Eremon area are into the shea processing and most people depend on it for so many things such as cream, pomade, medicinal purpose, food but to mention but few to mention. Socially, economically, traditionally it is a contribution factor to the daily livelihood activities" (Interview with the Paramount Chief of the Lawra Traditional Authority).

From the excerpt above, the researcher noticed that the paramount chief considered the processing of shea into butter, pomade and other products as an economic system of the people. This implies that the people depend on shea tree products for economic purpose. The thought of the paramount chief is buttressed by the community members in the focus group discussion. For instance, the focus group discussion with discussants from Dikpe community in the Lawra zone revealed that,

"*One importance of the shea-nut-trees is, I think some years back, the she butter used not to be expensive but now, the market price for it is very high so it has huge economic interest*" (Focus Group Discussion with Community Members of Lawra Zone at Dikpe).

The excerpt shows that the shea butter is sold at a high price, and that has added economic benefit for members of the community. This confirms the position of the paramount chief that the shea tree provisioning ecosystem services provide economic system for the people of the municipality. The researcher therefore, narrowed the provisioning services of shea tree into survey items to elicit from 387 members of the municipality their views on the provisioning services of shea tree.

In trying to find out some of the ecosystem services derived from the shea tree in the study area, some of the questions asked focused on products such as food, shea nuts, shea butter, bark and leaves for herbal medicine, fruits, fuelwood, charcoal, fodder from leaves, shea pods and seeds for livestock consumption, and caterpillars. Chart 2 below shows the responses of participants in six scale degrees of completely disagreed, strongly disagreed, disagreed, agreed, strongly agreed and completely agreed with any of these statements.

Responses by the respondents indicate that the shea tree provides all these ecosystem services to natives and residents of the Lawra Municipality. Regarding the first question as to whether the fruits and nuts of the shea tree provides food for residents, only one respondent representing 0.3% of the total respondents disagreed. The rest of the respondents who cumulatively represent 99.7% of the total respondents either agreed, strongly agreed or completely agreed that the fruits and nuts of the shea tree are sources of food for them. This revelation from the survey confirms what was said by a community member in the focus group discussion in one of the communities. The participant in the focus group discussion asserted that,

"*Also, during the fruiting season of the shea tree, it serves as a major source of food for many people. These days, the fruits start ripening around June/July and that is the beginning of the lean season when so many people begin to lack food in their homes. So, the shea fruits serve as a major source of food for many farmers and even some entire families. When the farmer goes to farm around this time, he usually doesn't expect food to be brought to him from home. So, if there is a fruity*

shea tree nearby, he works till about noon then he harvests the ripe fruits, eat and gets energy to continue his farming activities" (Focus Group Discussion with Community Members of Dowmini-Eremon Zone at Baazuri).

The excerpt shows that shea tree provide food for the community members. The participant further showed that the food from shea tree is very crucial because it happens at a time called *lean season*, thus a season where food is scarce for most people in the municipality. This is possible because the Lawra municipality depended largely on farming as main economic activity. The farming however, is a largely subsistent farming, and the raining season of Northern regions is one thereby making farmers use a season food for the entire year. This dependence on one season rainfall for farming activities makes it difficult for the people to have enough food for the entire year. The presence of shea tree food at such *lean season* provides a food support for members of the community.

On income, the survey results as indicated in Chart 2, also confirm that, the shea tree also serves as a source of income demonyms of the Lawra Municipality. Even though 12 of the respondents representing 3.1% indicated that they disagree that the shea tree is a source of income, 32 representing 8.3%, 95 representing 24.5% and 248 representing 64.1% of the respondents respectively indicated that they agreed, strongly agreed and completely agreed with that assertion. This assertion is shared by all the interviewees during the interviews conducted and community members in all the three focus group discussions held in the study area. For instance, the following excerpts show the responses of community members from the different zones on the provisioning ecosystem service of providing income.

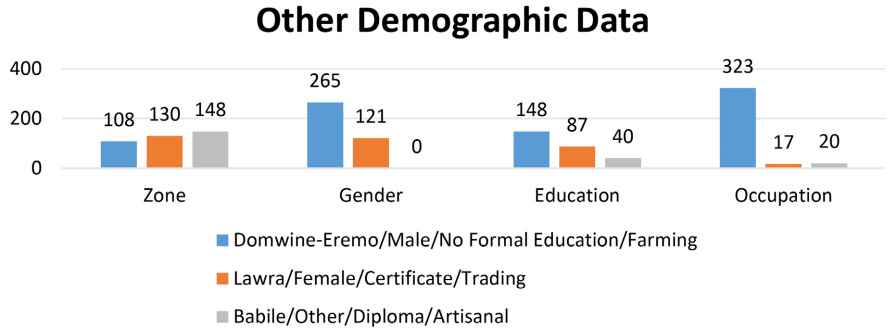

Chart 1. Distribution of other demographic variables in the study. Source: Field Data.

"*The shea fruits are our source income for us to be taking care of our families*" (Focus Group Discussion with Community Members of Dowmini-Eremon Zone at Daazuri).

The discussant in the focus group indicated that the money from the shea products helps to take care of their families. This view is shared by discussants from the Lawra zone. The discussant states,

"*One of the helps we get from shea tree is, we always collect the shea- fruits, use some to prepare butter for domestic use and sell some of the nuts and butter to buy maize. Also, from shea nuts and fruits, we can get money to buy ingredient to*

prepare food. In that, they have so many importance to us." (Focus Group Discussion with Community Members of Lawra Zone at Dikpe).

The discussant showed that the fruits are collected and the seeds of the fruits are processed into butter for sell. This supports the provisioning service of income from shea tree products.

Regulating Services

Regulating services are benefits obtained from regulation of ecosystem processes. Such benefits include climate regulation, disease regulation, water regulation, water purification and pollination.

Besides the provisioning ecosystem services, the shea tree also provides other ecosystem services to communities in the Lawra Municipality. However, while stakeholders of shea conservation and community members could readily mention the material benefits (provisioning ecosystem services) they derive from the shea tree during the interviews and focus group discussions respectively; their discussions and explanations barely mentioned the other ecosystem services they derive. However, in the survey, most of them indicated that they derive ecosystem services from the shea tree besides the provisioning services. Perhaps, the interviewees did not have knowledge in ecological studies and therefore did not know that the other ecosystem services provided by the shea tree actually constitute benefits provided by the tree. Also, the low level of education among the local inhabitants could inhibit their realization that the other ecosystem services they obtain from the shea tree constitute benefits as well.

Below is a bar **Chart 3** indicating the results of responses from respondents regarding the regulating ecosystem services provided by the shea tree in the Lawra Municipality.

Results in **Chart 2** indicate that the shea tree is a source of shade for residents of the Lawra Municipality. Generally speaking, trees are very important in providing shade and reducing heat islands within human settlements (Schell et al., 2020). When asked whether trees provide shade/shelter and reduce heat in the environment, most of the respondents agreed. From the graph, no respondent strongly disagreed with the statement while only one respondent representing 0.3% disagreed strongly with the statement. Those who indicated that they disagreed with the statement were just 10 and that represents 2.6% of the respondents. In effect, only 2.9% of the respondents contested the idea that trees provide shade and shelter which reduce environmental heat. The rest of the 98.1% of the respondents agreed with the statement. Out of this percentage, 107 respondents representing 27.6% of the respondents agreed with the statement while who strongly agreed with it were 79 and those respondents constitute 20.4% of the total respondents. Almost half of the respondents completely agreed that trees provide shade and shelter which help to reduce environmental heat. Those who shared this view were 190 in number and that represents 49.1% of the total respondents.

The views of the majority of respondents was echoed at Dikpe when they were asked how they manage with the heat in this era of rising temperatures. A discussant asserts:

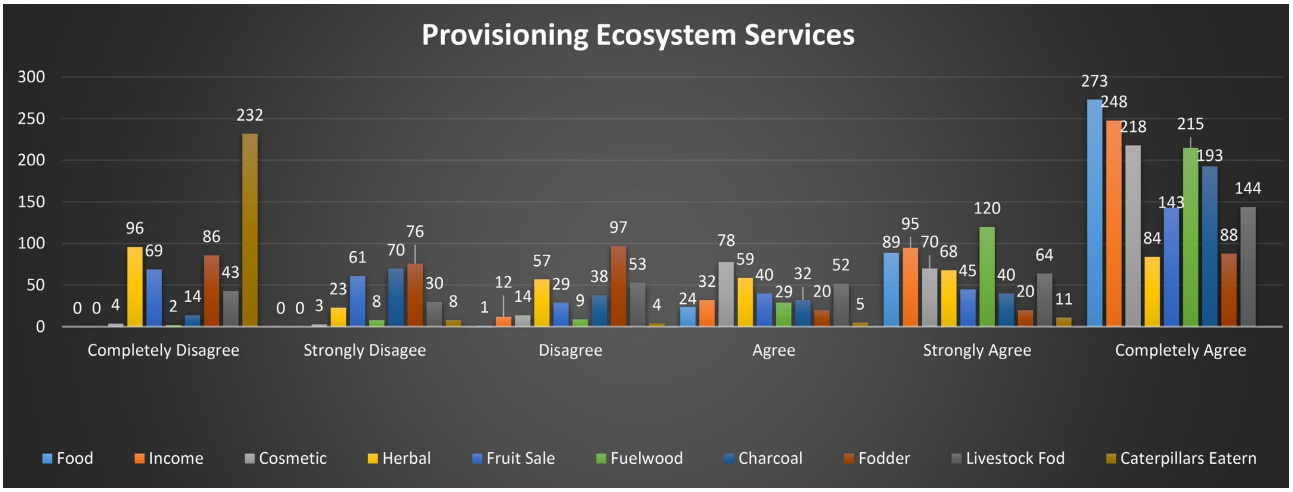

Chart 2. Distribution of provisioning ecosystem services among participants of Lawra Municipality. Source: Field Data.

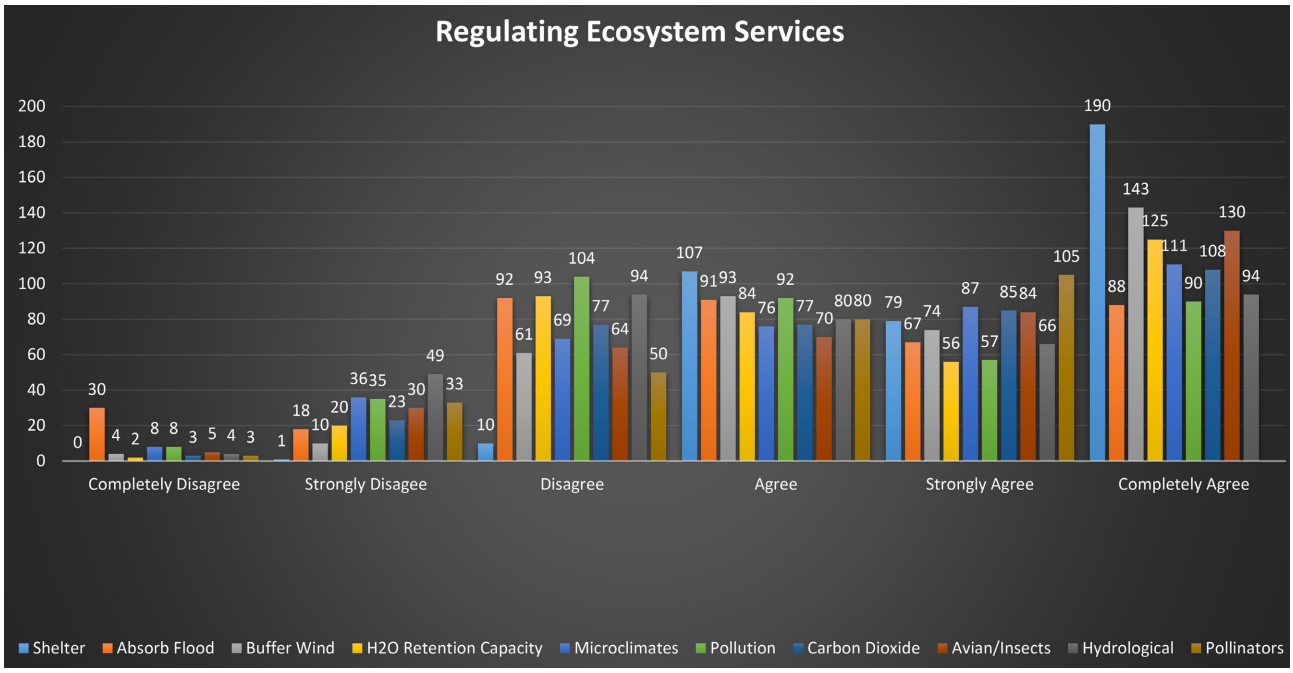

Chart 3. Distribution of regulating ecosystem services among participants in the Lawra Municipality. Source: Field Data.

"*Those with lights and can buy fans are able to cope but those who cannot, sleep outside during the night and during the day, we sit under trees*." (Focus Group Discussion with Community Members of Lawra Zone at Dikpe).

In the excerpt, the participants make money for shea tree to buy fans for heat regulation, and they *sit under* trees to enjoy shelter during the heat of the day. Another respondent in Babile zone also confirmed this as follows,

"During the day, we take shelter under the trees around the house. When we are in our farms, we take shelter under any tree with enough shade when the sun becomes too hot" (Focus Group Discussion with Community Members of Babile Zone at Kumasaal).

From the discussion, it is evident that the provision of shade/shelter is not derived specifically from the shea tree. Any tree with a rich canopy does that. But it is evident that provision of shade or shelter is certainly a regulating ecosystem service provided by the shea tree.

Evident abound that there is exponential decrease in water erosion rates with increasing root mass. Vegetative cover is instrumental in controlling erosion in general but the roots of trees are play a very important role in preventing interrill erosion. This assertion is largely supported by the respondents. Those who completely agreed that the roots of shea trees prevent erosion were 134 representing 34.6% of the respondents and those who strongly supported the idea were 73 representing 18.9%. Respondents who were of the opinion that the roots of shea trees prevent erosion were 96 representing 24.8%. However, two respondents completely disagreed while eight strongly disagreed. These represent 0.5% and 2.1% respectively of the total respondents. Those who disagreed were 74 representing 19.1%. In summary, the ability of tree roots to prevent erosion is a scientific fact and views of respondents in Lawra about the ability of the roots of the shea tree to do reflect this scientific reality.

Cultural Ecosystem Services

Cultural services are the nonmaterial benefits obtained from an ecosystem. These include spiritual and religious, recreation and ecotourism, aesthetic, inspirational, educational, sense of place and cultural heritage. Supporting services are those necessary for the production of all other ecosystem services. They include soil formation, nutrient cycling and primary production.

The shea tree is a non-forest tree resource that provides enormous benefits to people within where it is located. The tree is usually distributed in parks and thus, has its own ecosystem or in conjunction with other trees (Boffa, 2015). Just like any other ecosystem, there are, therefore, some ecosystem services derived from the shea tree. However, while there are different ecosystem services derived from every ecosystems of which cultural services is one of them, a careful analysis of these services indicates that most of them under the provisioning services have cultural undertones. There are numerous definitions of culture but all discussions about the subject matter indicate that, there are two components of culture: material culture and nonmaterial culture. The material component includes physical objects such as tools and technology, houses, clothing and food. The nonmaterial component comprises beliefs, values, norms, symbols and language. Therefore, as cultures vary, the type of ecosystem services provided by a particular ecosystem will also definitely vary even if that ecosystem is exactly the same at the different locations.

Society also derives cultural benefits from ecosystems and all benefits an ecosystem provides that have cultural significance are referred to as cultural ecosystem services. The shea tree is an indigenous tree in the northern part of Ghana. The tree and its products have indigenous names among the demonyms who live in its biome. In the Lawra Municipality, the shea tree is called tãngãã or tããntɛ in the Dagaare language which is the indigenous language in the area. A single shea fruit is also called tãngãã but many of them are called tããmã. The principal

product of the shea tree is the shea butter produced from the shea nut. The nut from which the butter is produced is called kyoone and many of them are called kyoomã. The shea butter itself is called kãã. Since language is part of culture, the indigenous names associated with the shea tree indicate that there is a cultural association with it. Therefore, the cultural significance of the tree in the form of ecosystem services is presented in the chart following.

Even though the shea tree is not unique to the residents of Lawra, knowledge about it forms part of the local heritage of the people. When asked to indicate whether traditional knowledge of shea trees is part of local heritage, four respondents representing 1% completely disagreed while 17 of them strongly disagreed. Another 30 respondents representing 7.8% disagreed. However, a cumulative percentage of 85.7% of the respondents have agreed generally that knowledge about shea trees is part of their local heritage.

Shea butter production is also an important cultural tradition of the local people of the study area. From Chart 4, 157 respondents, representing 40.6% completely agreed that shea butter production is an important cultural tradition among them and this view was also strongly supported by 123 respondent, representing 31.8%. Respondents who were of the view that shea butter production is organically part of their tradition were 83 representing 21.4%. These responses are in direct congruence with the views of some of the interviewees and community discussants. For instance, the paramount chief opined that,

"*During cultural practices where sacrifices are made, they usually demand for the shea butter at the early stage for the immediate performance to take place before any other activities or performance.*" (Interview with the Paramount Chief of the Lawra Traditional Authority).

From the paramount chief perspective, shea butter is a crucial part of the cultural ritual practice of sacrifice. The shea butter is used *early stage for the immediate performance* in sort of opening up the rest of the ritual performance. She sees the collection and sale of shea nuts as crucial for raising income for taking of basic needs of the family. This by extension could include affording medicines for health purposes. This was accentuated by the paramount chief as follows:

"*The shea plays a very vital role in our economic system especially within the Lawra Municipality. Most people in Eremon are into the shea processing and most people depend on it for so many things such as cream, pomade, medicinal purpose, food just to mention a few. Socially, economically, traditionally it is a contribution factor to the daily livelihood activities*" (Interview with the Paramount Chief of the Lawra Traditional Authority).

These views were largely supported by majority of the respondents in the survey. More than half of the respondents-196- representing 50.6% completely agreed that local diets, foodways and medicines involve sea tree products and those who strongly supported that view were 110, representing 28.4%. Respondents who agreed with the view were also 110 and their number represents 11.6% of the total respondents. However, the views of some respondents differ from this

popular view. Two respondents, representing 0.5% of the total respondents completely disagreed that shea products form part of the local diets, foodways and medicines of the indigenes of Lawra Municipality and a further 6 respondents constituting 1.6% strongly disagreed. Another group of respondents representing 5.9% also disagreed with this view. Even though some of the respondents held a different view that local diets, foodways and medicines do not contain shea products, the views of the majority synchronize with the views and findings of many shea researchers (Boffa 2015; Maanikuu & Peker, 2017; Venturini et al., 2016). These authors are all of the view that products of the shea tree form an integral part of the diet and healthcare system of residents in areas where the tree is located. Therefore, the views expressed by majority of the respondents resonates with other findings and it is very likely to be the true situation on the ground.

The presence of shea butter in some meals or dishes epitomizes delicacy and this is reflected in the local language of the area-Dagaare. A detailed response to the question as to whether the local language contains terms that reflect the importance of shea to livelihoods revealed that, the presence shea butter in most meals gives them the ideal palatable taste. A female discussant describes this as follows:

"*The taste of shea butter in many dishes makes the taste of it complete. In the Dagaare language, a delicious meal is figuratively called bondikãã, to wit, a buttered dish or meal. Food is bondiraa or bondirii and the shea butter is kãã so, a meal that contains shea butter is called bondikãã. What this means is that, without the shea butter present in that dish or meal, it cannot be delicious. This indicates how important the shea butter is in our cuisine*" (Focus Group Discussion with Community Members of Babile Zone at Kumasaal).

Despite this pithy statement about the importance of shea and its products to livelihoods, it is quite astonishing that 22.5% of the respondents generally disagreed that the Dagaare language contains terms that reflect the importance of shea to livelihoods. With their disagreement notwithstanding, the agreement of the 87.5% demonstrates the centrality and importance of shea in Dagaaba discourses.

Supporting Ecosystem Services

The supporting ecosystem services create the right conditions for the other ecosystem services to thrive. They are not immediate services enjoyed by humans. Rather, they are "intermediate services generated through the internal functions of the ecosystem which neither deliver any products nor vary any environmental conditions that can be used instantaneously by people but patronize/buttress all other eco-system services to be used for human well-being" (Khan, 2020). He acknowledges that the ecosystem services are very difficult to operationalized because, the services under this category are internal ecological processes which are not directly used by humans. This might explain why none of the interviewees or discussant ever mentioned any supporting service provided by the shea tree during the data collection process. However, when asked some of the possible supporting ecosystem services provided by the shea tree in the survey instrument, the respondents were able to provide ideas on all of them. Their responses are presented in the bar **Chart 4** below.

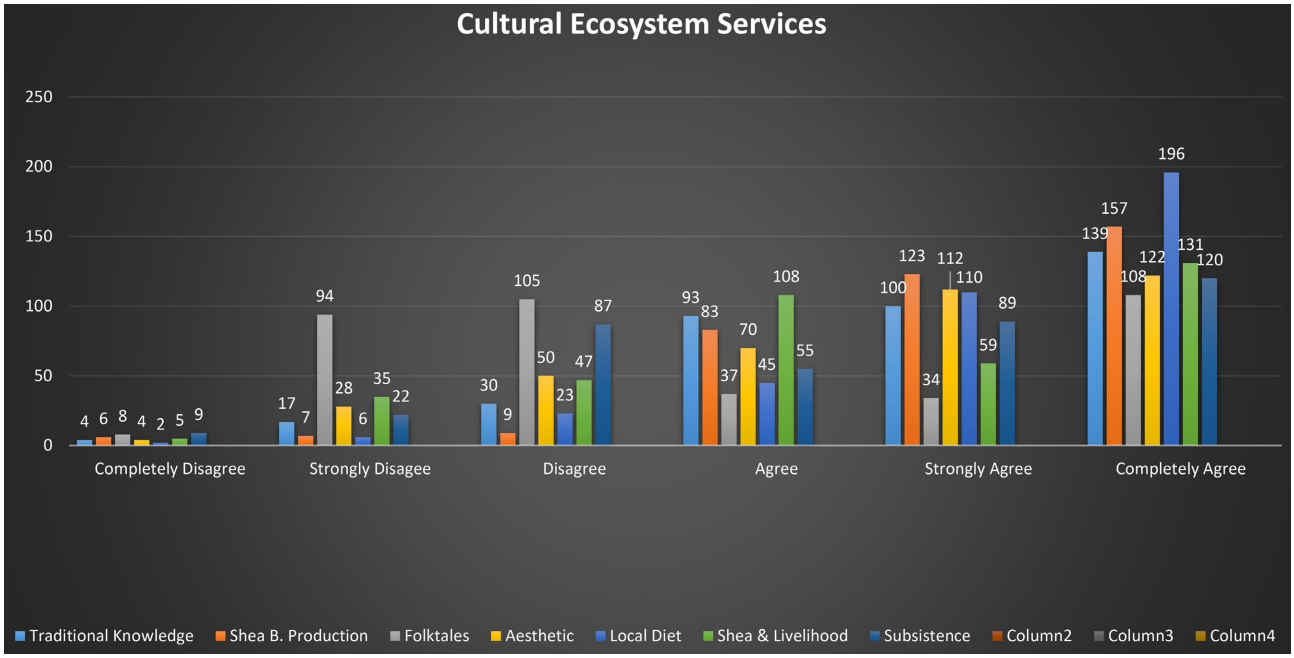

Chart 4. Distribution of cultural ecosystem services among participants in the Lawra Municipality. Source: Field Data.

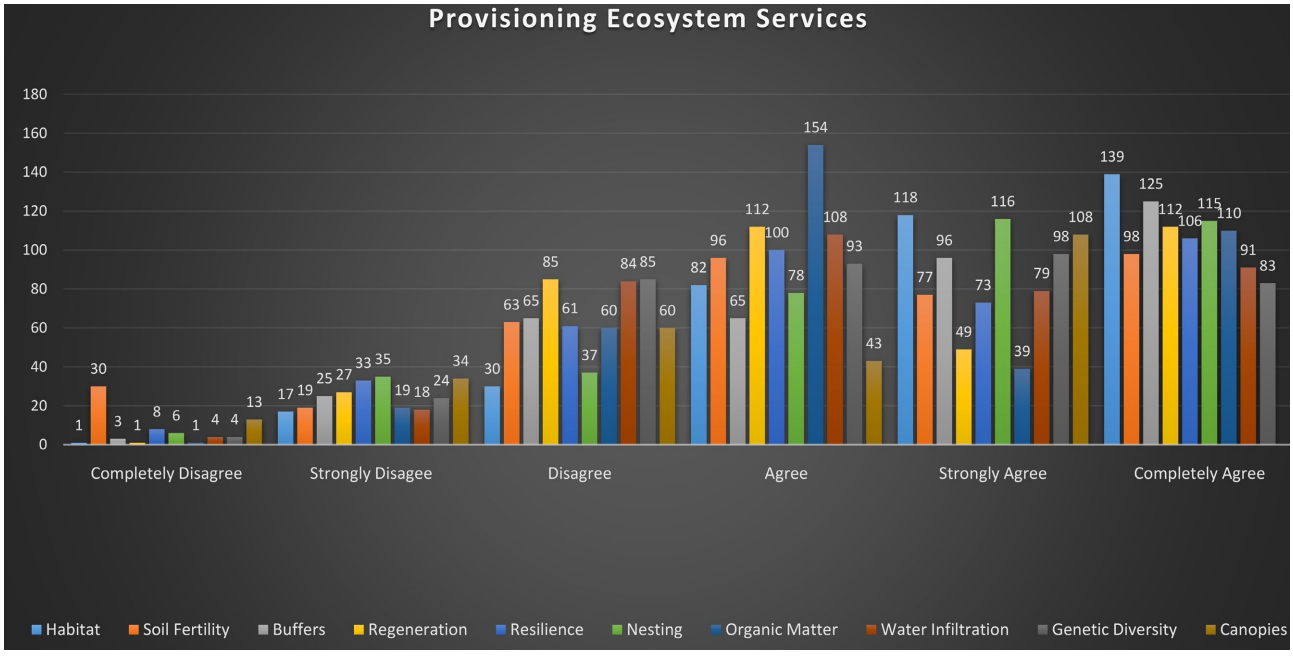

Chart 5. Distribution of supportting ecosystem services among participants in the Lawra Municipality. Source: Field Data.

Obviously, every tree is a habit for at least a living organism. As noted by Schell et al. (2020), trees and other plants even in built environments like cities and towns entice birds and other animals to move there and colonize those environments. It has therefore, been observed that the more an area has plant life, the more the biodiversity associated with it. The shea trees usually stand in conglomerates called parks. The trees serve as places of abode for a number of animals (Boffa, 2015). As observed by Payne et al. (2020), the shea caterpillar feeds on only

the leaves of the shea tree and that indicates that the shea tree is its only habitat. The shea tree therefore serves as a habitat for many animals and these animals work independently and in concert with their physical environment to support the proper functioning of the ecosystem. This fact appears to be largely supported by the respondents as only one of them representing 0.3% completely disagreed with the shea tree being a habitat for birds and other habitats with 17 of them representing 4.4% also strongly disagreeing. Respondents who disagreed were 30 as indicated on the graph and they represented 7.8% of the total population, as shown in **Chart 5**. The rest of the respondents representing 88.6% of total respondents however agreed with varying degrees of agreement. The general response on the subject matter is in consonance with what is in literature testifying that shea trees are certainly habitats for birds and other living organisms.

There is no evidence in literature to prove that the roots of shea trees fix nitrogen in the soil. However, Nitrogen has been found to greatly enhance the growth of shea seedlings. According to Adelani et al. (2021), leaf litters of Nitrogen fixing acacia trees applied on shea seedlings influenced the growth of the shea seedlings significantly. Despite the significant influence of Nitrogen on shea seedlings, its influence on mature shea trees has not been fully proven (Abubakari, et al., 2012). "Although, the role of N in Shea seedling regeneration is appreciated, its role on the mature Shea tree is not comprehensively reported", they emphasized. The views of some respondents however differ from what has been documented. Deducing from **Chart 5**, Ninety-eight of the respondents representing 25.3% completely agreed that shea roots help to fix Nitrogen in the soil and this view was supported by an additional 77 respondents who represent 19.9% of the respondents. A further 96 respondents who represent 24.8% agreed with the notion that shea roots are sources of Nitrogen in soils. However, a total of 112 respondents representing 29.2% disagreed with varying levels of vehemence that she trees fix Nitrogen in soils. The wide support for the view that shea trees fix Nitrogen in soils could be attributed to improved yields of crops they might have noticed on their farms.

According to Baziari (2015), maize yields were found to be higher around the edges of shea trees crowns as compared to open fields. "This suggests that tree density had an effect on creating microclimates at the canopy edges and the area between canopies", he opined. If farmers in the Lawra Municipality also noticed this trend of crops providing better yields at the crown edges of shea trees, some of them could misinterpret that to mean the roots of shea trees fix Nitrogen in the soil but this is not supported with any scientific evidence.

4.6. Shea Tree's Ecosystem Services and Climate Change Adaptation in the Lawra Municipality

Ecosystem services play a very vital role in climate change mitigation and adaptation (Potschin et al., 2016). With mitigation, they help to sequestrate carbon from the atmosphere and store it. Regarding adaptation, they provide services that can help people adapt to both current climate hazards and future climate change.

Since ecosystem services can help people adapt to current and future hazards of climate change, it is important to determine the current hazards (climate change manifestations) in the study area; hence, the second question focused on how do these ecosystem services, if any, help in climate change adaptation in the study area?

4.7. Provision Ecosystem Services Impact on Climate Change Adaptation

Table 2 below shows the results of OLS analysis for the first specific variable of provision ecosystem system service.

Table 2. Distribution of OLS results on provision ecosystem service impact on climate change adaptation. Source: Field Data.

Source	SS	df	MS	Number of obs	=	318
Model	24.7577724	10	2.47577724	F (10, 307)	=	3.52
Residual	216.025246	307	.703665298	Prob > F	=	0.0002
Total	240.783019	317	.759567883	R−squared	=	0.1028
				Adj R−squared	=	0.0736
				Root MSE	=	0.83885
ACC4	Coefficient	Std. err.	t	P > |t|	[95% conf.interval]	
POS1	.3939039	.0809811	4.86	0.000	.2345557	.5532521
Farm_size	−.0250118	.0690882	−0.36	0.718	−.1609583	.1109346
distance_from_shea	.0428337	.0717379	0.6	0.551	−.0983265	.183994
member_of_group						
Yes	.039743	.1473123	0.27	0.788	−.2501266	.3296127
leadership_role						
Yes	−.2437512	.1263752	−1.93	0.055	−.4924225	.00492
years_in_area	.004478	.0035592	1.26	0.209	−.0025255	.0114814
Education						
Certificate	.010497	.1271694	0.08	0.934	−.239737	.260731
Diploma	.1432879	.1624193	0.88	0.378	−.176308	.4628838
Degree	.3992421	.2937538	1.36	0.175	−.1787836	.9772678
Sex						
Female	−.1796413	.1222101	−1.47	0.143	−.4201168	.0608342
_cons	1.866677	.4474673	4.17	0.000	.9861858	2.747168

On ecosystem provision service of shea nut for food impact on shea tree climate adaptation, the researcher discovered that there is significant influence of shea nuts for food on the adaptation techniques of the participants. From Table 3 below, it is seen that dependent variable climate change adaptation was regressed on predicting variable of provision ecosystem service of shea nut for food. The inde-

pendent variable of provision ecosystem service significantly predict climate change adaptation s indicated F (10, 304) = 0.0002, $p < 0.000$) which indicates that the ecosystem provision service has significant impact on the climate change adaptation.

Additionally, coefficients were further assessed to ascertain the influence of each of the factors, thus provision ecosystem system, age, sex, education, farm size and distance from home on the climate change adaptation. The results showed that provision ecosystem service has a significant and positive impact on climate change adaptation with (B = 0.393, t = 4.86, $p = 0.000$). This supported the H1.

From Table 3, it is obvious the provision ecosystem services correlated with the climate change adaptation based on the Ordinary Least Square regression analysis revealed that ecosystem services has a significant positive impact on the climate change adaptation of community members. This finding is very crucial because the elaborate and significant consent of the participants on the provision ecosystem services derived from shea tree definitely will impact their willingness to support adaptation measures for conserving the shea tree. This is consistent with findings of authors who argued that when community members benefit from the ecosystem; they tend to commit themselves to its conservation thereby their willingness to accept and practice adaptation techniques (Abdulai et al., 2017). This also implies that communication along the provisional ecosystem services of shea trees as the basis for community members to conserve the shea tree through climate change adaption will significantly resonate with their indigenous knowledge and thereby promote acceptance of the adaptation techniques.

Table 3. Distribution of OLS results on provision ecosystem service impact on climate change adaptation.

	Regression Weights	B	t	*p*-value	Hypotheses
H1	POS1 - ACC4	.393	4.86	.000*	**Supported**
H2	POS2 - ACC1	.573	3.26	.001*	**Supported**
R	0.92 F (10, 304)				

Note* $p < 0.05$; POS1—Provision service item 1; ACC4—Adaptation to climate change 4; POS2—Provision Service 2; ACC1—Adaptation to climate change 1.

5. Conclusions and Recommendations

In conclusion, this study has revealed that demonyms of Lawra municipality has adequate knowledge of ecosystem services derived from the shea tree. The services derived from shea tree ranged from food, income, cosmetics, buffers, habitat, shelter microclimates, folktales and aesthetic. These services were grouped under provisioning, supporting, regulating and cultural ecosystem services. Moreover, the study showed that ecosystem services, especially the provisioning ecosystem service, have a positive and significant influence on the climate change adaptation among demonyms. The impact of the ecosystem services as revealed in the focus group discussion was largely guided by the instrumental role of traditional rulers

who provide bye-laws, norms and security for conserving the shea tree. This emphasized the efficacy of transformational leadership behavior (Robertson & Bailing, 2013) in promoting pro-environmental behaviors among community members.

The researchers recommend that policy framework for climate change adaptation should focus on capitalizing the existing relationship between ecosystem services and climate change adaptation. Furthermore, there is the need for local government officials to be trained and equipped with tools to combat the threat of shea tree in the Lawra municipality. The present study has empirically provided evidence of relationship between ecosystem services and shea tree climate change adaptation. This knowledge advance a plausible solution to tackling anthropogenic factors that threaten shea tree conservation in that, by leveraging on existing knowledge of demonyms on ecosystem services and climate change adaptation; climate change communicators and advocates could design programmes that resonate with demonyms existing knowledge and perceptions. The present study relied on the express opinions of the participants on climate change adaptation and ecosystem services; hence generalizing the study findings on other contexts might be problematic due to context-specific and socio-demographic factors (Abdulai et al., 2017). Therefore, the researcher recommends further studies on ecosystem services and climate change adaptation on the shea tree or other plant species in Ghana or abroad.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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